IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Yoji Ito et al.
    Group Art Unit: 2871
    Serial No.:   10/520,732
    Examiner: Nathanael R. Briggs
    For: LIQUID CRYSTAL DISPLAY HAVING
    LIQUID CRYSTAL CELL OF BEND
    ALIGNMENT MODE OR HYBRID
    ALIGNMENT MODE

DECLARATION PURSUANT TO RULE 132

Honorable Commissioner of Patents and Trademarks
Washington, D.C.

I, Yoji Ito, one of the above-named applicants, declare and state that:

I hereby submit experimental data obtained by experiments, which were recently performed by me.

Summary

In the following Comparative Experiment, I prepared a liquid crystal display of OCB mode in a similar manner as in Example 5 given in our specification on pages 75-82, except that a fluorine-containing polymer was not used in preparation of the first optically anisotropic layer of the optical compensatory film.

I measured retardation the values Re(0), Re(40) and Re(-40) of the first optically anisotropic layer. The results are set forth in Table A.

I further evaluated the optical compensatory film and the liquid crystal display of OCB mode. The results are set forth in Table B.

In Tables A and B, the results of Examples 5 and 6 given in our specification on pages 75-88 are set forth again for comparison.

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Comparative Experiment

(Formation of first optically anisotropic layer)

In 102 kg of methyl ethyl ketone, 41.01 kg of the discotic liquid crystal compound used in Example 1 (given in our specification on page 41), 4.06 kg of ethylene oxide denatured trimethlolpropanetriacrylate (V#360, Osaka Organic Chemicals Co., Ltd.), 0.35 kg of cellulose acetate butyrate (CAB-531-1, Eastman Chemical), 1.35 kg of a photopolymerization initiator (Irgacure 907, Ciba-Geigy) and 0.45 kg of a sensitizer (Kayacure DETX, Nippon Kayaku Co., Ltd.) were dissolved to prepare a coating solution. While the second optically anisotropic layer was transferred at 24 m/minute, the coating solution was continuously spread to coat the orientation layer on the second optically anisotropic layer prepared in Example 5 (given in our specification on pages 75-77) by means of a wire-bar of #2.7 rotating at 391 rpm so that the rotation might follow the transference.

The temperature was continuously raised from room temperature to 100°C, to dry the spread solution. The coated film was then transferred to a drying zone heated at 135°C, and exposed to flowing air for approx. 60 seconds so that molecules of the discotic liquid crystal compound might be aligned. In the drying zone, the air was made to flow at the speed of 5.3 m/sec near the film surface. Successively, the film was further transferred to another drying zone heated at 80°C, and exposed to ultraviolet rays of 600 mW for 4 seconds with the surface of support heated at approx. 100°C (surface temperature). The ultraviolet rays were emitted from a UV exposure apparatus [power of UV lamp: 160 W/cm, length of lamp: 1.6 m]. Thus, the aligned discotic liquid crystal molecules were fixed. After cooled to room temperature, the film was cylindrically wound up into a roll to produce a rolled optical compensatory film.

The viscosity of the first optically anisotropic layer was measured at the surface temperature of 133°C,

and found 700 cp. In the measurement, a liquid crystal layer comprising the same components (except the solvent) as the first optically anisotropic layer was prepared and its viscosity was measured with an E-viscosimeter of heating type to estimate the viscosity of the first optically anisotropic layer.

A piece of the rolled optical compensatory film was clipped and used as the sample in the evaluation of optical characters. The results are set forth in Table A.

It was found that in the first optically anisotropic layer, the angle between the discotic plane of discotic liquid crystal molecule and the surface of support (namely, inclined angle) varied continuously according the depth and was 37° on average. Further, after only the first optically anisotropic layer was peeled from the sample, the average direction of lines of molecular symmetry in the first optically anisotropic layer was measured and found that the lines of molecular symmetry were oriented on average at 40° to the longitudinal direction.

The sample was placed between a pair of polarizers (Glan-Thompson prisms), and alignment of the molecules in the first optically anisotropic layer was measured. The optical elements were arranged so that the transmission axis of incident polarizer, the slow axis of transparent support, the slow axis of optically anisotropic layer were at angles of 90°, 20° and 155°, respectively, when seen from the outward polarizer. In that arrangement, the smallest $100 \times (T-C)/(P-C)$ was observed when the outward polarizer was placed at 185°. The smallest $100 \times (T-C)/(P-C)$ was 0.0038.

The polarizers were placed in crossed Nicols arrangement, and then it was observed whether an image given by the optical compensatory film had defects or not. As a result, no defect was observed when the film was seen frontally or obliquely at 60° to the normal.

(Preparation of polarizing plate)

The optical compensatory film was laminated with a polyvinyl alcohol adhesive on a polarizing membrane so that the support-side of the film might be in contact with the membrane. On the other hand, a commercially available triacetyl cellulose film (thickness: 80 µm, TD-80U, Fuji Photo Film Co., Ltd.) was saponified and laminated on the opposite surface of the polarizing membrane with the polyvinyl alcohol adhesive.

The polarizing membrane, the second optically anisotropic layer and the commercially available triacetyl cellulose film were placed so that their longitudinal directions might be parallel to each other. Thus, a polarizing plate comprising (only) the optical compensatory film was produced.

Independently, the optical compensatory film was laminated with a polyvinyl alcohol adhesive on a polarizing membrane so that the support-side of the film might be in contact with the membrane. On the other hand, a commercially available anti-reflection film (Clear View UA, Fuji Photo Film Co., Ltd.) was saponified and laminated on the opposite surface of the polarizing membrane with the polyvinyl alcohol adhesive.

The polarizing membrane, the transparent support and the commercially available triacetyl cellulose film were placed so that their longitudinal directions might be parallel to each other. Thus, a polarizing plate comprising the optical compensatory film and the anti-reflection film was produced.

(Preparation of liquid crystal display)

The polarizing plate comprising (only) the optical compensatory film and the plate comprising the optical compensatory film and the anti-reflection film were laminated on the liquid crystal cell prepared in Example 5 (given in our specification on pages 80-81), so that the cell might be between the plates and so that the plate comprising both compensatory film and anti-

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reflection film might be on the viewer side. The plates were arranged so that the first optically anisotropic layer in each plate might face to the cell substrate and so that the rubbing directions of the cell and the first optically anisotropic layer might be anti-parallel.

(Evaluation of liquid crystal display)

Voltage of a square wave (55 Hz) was applied to the liquid crystal cell. An image was displayed according to normally white mode (white: 2V, black: 5V). A ratio of transmittance (white/black) was measured by means of a meter (EZ-Contrast 160D, ELDIM) at eight displaying states of L1 (full black) to L8 (full white), to determine the contrast ratio. A front contrast (CR: ratio of brightness in displaying a white image/a black image) was also measured.

The results are set forth in Table B.

The liquid crystal display was adjusted to display an image of half tone as a whole, and it was observed whether the displayed image had defects or not. As a result, a lattice pattern was observed when the display was seen from a direction showing a reversal image (55° or more upward or 60° or more downward).

TABLE A

Optical compensatory film	Fluorine-containing polymer	Re(0°) 30±10 nm	Re(40°) 50±10 nm	Re(-40°) 115±10 nm
Example 5	Added	30.5 nm	44.5 nm	107.5 nm
Example 6	Added	34.3 nm	51.2 nm	120.5 nm
Comparative Experiment	None	20 nm	32.5 nm	83.5 nm

TABLE B

Optical compensatory film	100×(T-C) P-C	Front contrast	Viewing angle (contrast>10)	
			up/down	left/right
Example 5	0.0033	480	80°/80°	80°/80°
Example 6	0.0029	530	80°/80°	80°/80°
Comparative Experiment	0.0038	450	60°/60°	60°/60°

Discussion

As is evident from the results shown in Table A, it is technically difficult to adjust the properties of Re(0°), Re(40°) and Re(-40°) appropriately without use of a fluorine-containing polymer.

As is also evident from the results shown in Table B, it necessary for showing an excellent image having wide viewing angles to adjust the properties of Re(0°), Re(40°) and Re(-40°) appropriately.

The undersigned declarant declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date September 21, 2007

YOJI ITO